

How much animal protein do we need? Is animal-based protein better than plant-based protein? Looking for evidence in the vegetarian, Mediterranean and other diets.

The large amount of animal protein that is currently consumed in western diets is a relatively recent phenomenon. The majority of the world eat a largely plant-based diet and it is only in relatively recent times that meat has become a major part of western diets. Prior to the shift to agriculture which started some 10,000 years ago, it has been argued that Palaeolithic man gained the majority of his nutrition from red meat consumption. However, there are great problems with this from a scientific point of view. Because of the limited data, some of which has been extrapolated back from modern times, definite statements made by those who produce red meat. A particular claim about the need for such foods for good brain development remains unproven scientifically. See the section on the Palaeolithic diet.

The scope of vegetarian diets. Modern vegetarian diets are based on a wide variety of foods, often much a much wider range than compared to meat-eaters. Vegetarians are more likely to consume unrefined carbohydrate foods, salads, fruit, nuts and pulses. Intakes of many nutrients are higher in vegetarians than consumers of more usual western diets: thiamine, folate, vitamin C, carotene, potassium and vitamin E. Energy wise, vegetarian diets are similar to meat eaters. The amount of energy derived from protein is about 12% much lower than current US intakes of around 27%. The lower value is quite adequate and may as will be shown in the section on dairy foods, be better for us. Sugar intakes are similar to those of non-obesity producing omnivorous diets. Intake of saturated fats which are strongly related to arterial disease are much lower in vegetarian diets, but intakes the unsaturated fats, linoleic and alpha linoleic acids, the base materials of important nervous system structural components, are higher. Fibre intake is much higher as well(Sanders 99).

How much protein do you really need? The daily intake of protein should be around 0.75g/day contributing about 9% of energy requirements. Breast milk which mankind evolved to consume and is the gold standard for nutrient intake of babies has 7% of its energy in the form of protein providing around 2.5g/kg/day of protein. During childhood protein requirement progressively fall towards adult levels at puberty. How do the major cereals compare to the protein supply in breast milk. Both wheat and maize provide a superior protein intake in comparison.

How do the protein intakes in countries where far less meat is consumed compare to other developed western nations? Take Egypt as an example: data from the FAO show that overall protein intake is not far below that of the UK, with the majority of protein coming form wheat (Modified from Millward 99).

	Protein intake g/d	Animal protein	Cereal protein g/d
--	--------------------	----------------	--------------------

		g/d	
Egypt	87	12.9	59.6
UK	91	53.3	22.9

Hence there are adequate amounts of protein in most of the food consumed around the world. Problems arise when the staple food has a very low protein content such as cassava, taro, yams etc or where the overall supply of food is inadequate. A possible limiting factor in plant-based foods that should be taken into consideration is digestibility, since not all protein can be extracted from the various food types, and this may lower the actual amount available. Animal protein sources have close to 100% digestibility. However, most of the commonly consumed cereals such as wheat, maize and soybean products have high digestibility of more than 80%, with many such as wheat flour being close to 100%. Hence digestibility is not a major factor in this equation.

Calculating our protein needs and understanding the limitations of such results. All that higher levels of protein intake do beyond that which is required to renew the body's own proteins and supply those amino acids that are converted into other essential metabolites, is to increase the breakdown of the component amino acids in excess of requirements. Changes in this latter adaptive mechanism occur slowly over a period of weeks in response to lowered protein intake, making it difficult to interpret shorter term studies of nitrogen balance.

Such short term studies may give the false impression of negative nitrogen balance and hence protein deficiency in relation to the acutely lowered intake encountered in the short term study. In fact it is the overrun effect of the adaptive mechanism that take weeks to re-set to the lower intake of protein. If further measurements of nitrogen balance were done after some weeks of the lowered intake, these may well show equilibrium. The lower limit of protein intake of 0.6g/kg/d was calculated from short term studies and in fact, this may well be an over estimate (Millward 99B). There are however, some paradoxes: it would appear that some people with osteoporosis who have the lowest but not abnormal protein intakes benefit from a higher intake leading to improvement of their osteoporosis. This has yet to be reconciled. See below.

Is vegetarian protein intake adequate, particularly for children? If a well chosen diet is consumed there is little problem. Difficulties only arise when a limited range of foods is consumed or the amount of energy available from a bulky low energy dense diet is inadequate. By and large, most vegetarians are in nitrogen balance indicated that enough protein is being consumed. Human also differ quite markedly from other animals in their growing phase. The amount of new protein deposited per day in growing children is very small compared to the amount of protein required for body maintenance. Hence human children (and other primates in their growth phase) don't require a higher protein intake than adults.

Breast milk is in fact a relatively low protein diet and is obviously adequate (Hegsted 2000). Does increased protein maternal diet increase the amount of

protein in milk? In western diets with excess protein, milk protein levels remain fairly constant, and hence there is no advantage and possibly some disadvantages in increasing the amount of protein, particularly animal protein in the mother's diet.

What about the reverse? Is too high a protein intake, particularly animal protein a problem? More is not necessarily better. In pregnancy, there are suggestions that protein supplementation may lower birth weight and a further possibility of hypertension in later life. Levels of intake were up to 100g/day of protein (Millward 99B). In adult life, increasing protein intake has no effect on protein turnover over a wide range of intakes between 0.36 and 2.07g/kg/d. While there appears to be no detrimental effect with high levels of protein intake except for the induction of osteoporosis (see osteoporosis), there is no benefit either (Millward 99B). The protein simply adds to the caloric intake and is wasteful of precious earth resources.

What about athletes? Do they require a greater protein intake? In one study, a group of body builders had protein intakes that varied from 0.63 to 3.05 g/kg/d (average 1.93). No discernible difference could be seen in their abilities. However, with increasing energy requirements associated with training it is difficult to avoid a progressive increase in protein intake. As an example, protein intake rises proportionately around 0.5 to 1.0 g/kg/d over the range of caloric requirements for additional physical activity from 1.5 to 2.25 Kcal/day in a number of different diets. Overall there appears to be no benefit from consuming high protein foods beyond that which is gained from eating normal non protein enriched foods (Millward 99B).

Do older people need more protein? There is little evidence in western countries that the elderly consume too little protein with average levels around 1g protein/kg of bodyweight. When people with the lowest intake of protein were examined, no deleterious changes were found by measuring such things as serum albumin, skin fold thickness and transferrin levels. No benefit was found in increasing protein intake except in people with the lowest protein intakes to reduce bone loss. See the section on osteoporosis. It has been noted that protein requirements decrease with age from levels around 1g/kg/d at 20years to about 0.6g/kg/d at 90 years (Millward 99B).

Issues with the quality of protein.

Is the quality of protein in plant-based foods the same as that in animal-based foods? There has been a widely held view, particularly by the producers of animal based foods, that we require animal derived proteins for proper nutrition because meats have a very similar amino content to that of human muscle. However, while this may seem logical on the surface, it is a largely unproven assertion. Major methodological difficulties are well recognized when it comes to actually measuring the minimum requirements of individual amino acids.

There is no direct way of measuring whether there is a deficiency of a particular amino acid unlike many other nutrients such as vitamins. The

calculation of the requirements for individual amino acids was originally done by nitrogen balance but in more recent times with the measurement of fixed isotope incorporation. The latter method has many difficulties and much controversy surrounds the values derived. For example, values obtained for lysine by fixed isotope incorporation studies are well above what many western healthy vegetarians consume. Recent re-analysis of nitrogen balance studies give a more realistic view.

The amino acid most likely to be in short supply in a purely plant based diet is lysine. Using data from the re-evaluated nitrogen balance studies reveal a much lower requirement, well within the range of vegetarian diets (Millward 99). Taurine is another amino acid that might potentially be in short supply. It is converted from cysteine if it is not supplied by eating meat, but some have suggested that this conversion is inadequate in the neonatal period. Despite the fact that vegans have markedly lower levels of taurine in their breast milk, these levels are still greater than in most baby formulas (Sanders 99).

In the 1990s when it was assumed that protein deficiency was a major problem in parts of the developing world, diets were enriched with lysine or threonine/lysine in an attempt to improve the quality of protein intake. The results of these programs were essentially negative (Hegsted 2000). As noted above, the human body adapts to the lowered intake of these amino acids well. Hence meat-free, largely plant-based diets in the west supply protein in the amount and quality sufficient for all age groups. In developing countries, if the dietary staple food has a low protein concentration such as taro, yams or cassava or has low digestibility such as millet or sorghum, protein malnutrition will occur. Diets based on wheat and maize have good levels of protein (Millward 99). Hence the widely held and deeply ingrained belief, reinforced vigorously by the animal protein producers that you must have animal protein for good nutrition, is without foundation.

Is animal protein associated with cancer? There is a lot of suggestive information that it is, particularly red meat, but the recent Nurses Health Study showed an increase in pre-menopausal breast cancer. See the discussion under vegetarianism.

What about iron intake? There is no doubt that one of the best sources of dietary iron is red meat – heme iron. A lot of plants have large amounts of iron and in fact the majority of our iron intake comes from plants, around 80% (UK Food Standards Agency) but its bio-availability is less. So why can't the body absorb it as well? First non-heme iron is taken up by a different less vigorous mechanism in the gut and is more tightly regulated. Second, many components in our food may inhibit iron from being absorbed. For example, phytates found in dietary fibre are not absorbed but bind iron which means that the iron is then lost in the faeces. Other inhibitors are tea, coffee and to a lesser extent, calcium.

Problems can arise if vegetarian diets have high levels of phytates such as eating large amounts of brown rice. However, phytates in cereals are broken down by yeast in bread making. There are many excellent non-meat sources

of iron: legumes, such as kidney beans, lentils and chickpeas, soya bean curd (tofu), nuts, seeds, wholegrains and dried fruits, such as raisins, prunes, apricots and figs, are all excellent sources of iron. For example, lentils contain 3.5mg iron per 100g, almonds 3mg, sesame seeds 10.4mg and figs 4.2mg. Many breakfast cereals are fortified with iron, providing another regular non-meat source.

Studies of many vegetarian groups have shown normal levels of haemoglobin (Sanders 99). Put the other way around, iron deficiency anaemia is no more common in vegetarians than in meat eaters in the west. Iron deficiency anaemia is relatively common in children. Of the many causes, cow's milk has been implicated on two grounds. The first is infant diets which contain excessive amounts of cow's milk. Cow's milk is low in iron (Thane 2000). Second, cow's milk may induce inflammation and bleeding in sensitive children, leading to iron deficiency from bleeding.

Do vegetarians have normal pregnancies? The answer is simply yes. Problems can arise if a very narrow range of foods is eaten such as might be seen in some of the faddish diets.

Looking at various diets

Statements by learned bodies on vegetarian diets. Here is what the American Dietetic Association and Dieticians of Canada have to say on vegetarian diets: "Appropriately planned vegetarian diets are healthful, nutritionally adequate and provide health benefits in the prevention and treatment of certain diseases." They quoted among others, the following scientific studies in support of their claim.

- **Colombo et al. 2005 Plant-based diet, serum fatty acid profile, and free radicals in postmenopausal women: the diet and androgens (DIANA) randomized trial.** The results indicated that a plant-based diet can improve the serum fatty acid profile and decrease reactive oxygen molecule production. These results suggest that a plant-based diet may reduce the body's exposure to oxidative stress.
- **Barnard et al 2005 The effects of a low-fat, plant-based dietary intervention on body weight, metabolism, and insulin sensitivity.** RESULTS: Mean +/- standard deviation intervention-group body weight decreased 5.8 +/- 3.2 kg, compared with 3.8 +/- 2.8 kg in the control group (P = .012). In a regression model of predictors of weight change, including diet group and changes in energy intake, thermic effect of food, resting metabolic rate, and reported energy expenditure, significant effects were found for diet group (P < .05), thermic effect of food (P < .05), and resting metabolic rate (P < .001). An index of insulin sensitivity increased from 4.6 +/- 2.9 to 5.7 +/- 3.9 (P = .017) in the intervention group, but the difference between groups was not significant (P = .17). CONCLUSION: Adoption of a low-fat, vegan diet was associated with significant weight loss in

overweight postmenopausal women, despite the absence of prescribed limits on portion size or energy intake.

- **Richter et al 2004. Age-dependence of lipid parameters in the general population and vegetarians.** To study possible influences of nutrition and life-style of vegetarians on age-dependence of lipid parameters, subjects of general population were compared with vegetarians. In the frame of population-based lipid screening projects in the city of Leipzig/Germany (Lipid Study Leipzig, LSL) 10 550 subjects (3,816 men and 6,734 women, age 18-99 years) of general population were compared with 417 vegetarians (vegans, lacto-vegetarians, lacto-ovo-vegetarians, 148 men and 269 women, age 18-93 years). Most of the vegetarians included in the study were members of the German Society of Vegetarians. The study program included capillary blood cholesterol measurements and the determination of high-density lipoprotein (HDL)-cholesterol, the measurement of other cardiovascular risk factors and the evaluation of dietary and life-style factors. Evaluation of cardiovascular risk profile within LSL was connected with individual consultation. The mean total cholesterol and non-HDL-cholesterol level and the total: HDL-cholesterol ratio showed the expected age-dependence, with maximum values within the decade 60-70 years. Vegetarians showed lower total and non-HDL-cholesterol levels in comparison with the general population. Furthermore, the age-dependent increase of these parameters is less pronounced under the conditions of vegetarian nutrition and life-style. Especially in young adulthood a significant difference is observed. Thus, the results of the present study reveal the role of nutritional and life-style factors that determine the lipid profile on a population basis and suggest that the known age-dependent rise of the level of atherogenic plasma lipoproteins is partly preventable.

The Mediterranean Diet

The advantage of the Mediterranean Diet. In the 20th century, it was noted that people in the Mediterranean area had unusually long life expectancies and low levels of chronic disease. Such changes could not be attributed to changes in living conditions as seen in other parts of the industrialized world and were tracked down to the largely vegetarian diet that was eaten. While risk factors for chronic disease are creeping in with the adoption of consumption patterns similar to others countries of the industrialized west, life expectancy in 1991 among Greeks at the age of 45 was 32.5 years compared to 33.3 years for the Japanese, but ahead of the USA (30.8), UK (30.9), and Canada (32.1) (WHO 1994) (Nestle 99) (Trichopoulou 97).

As noted in careful studies by several observers over several decades and while there are local variations, the Mediterranean diet is essentially high in vegetables and fruit, legumes and grains, with a low to moderate intake of dairy products and a low consumption of meat. Seafood intake varies in relation to proximity to the sea. There is often a moderate intake of alcohol in the form of wine and the ratio of monounsaturated to saturated fat is high. It is also of note that this diet seems to protect against the adverse effects of

cigarettes since their consumption is often high in these regions compared to other western countries (Trichopoulou 97).

Mediterranean diets are associated with less heart disease and cancer.

In more recent times, Trichopoulou and associates have looked outcomes in relation to how closely the Mediterranean diet was adhered to using a scientifically based scoring system from 0 to 9 (Trichopoulou 03). This was a meticulously done investigation involving more than 22,000 people. The clear answer was that the more closely such a diet was followed the lower the death rate due to both coronary artery disease (hazard ratio of 0.67) and cancer (HR 0.76). (Hazard ratios are a comparison of risk, with the usual risk being 1. If the HR is less than 1, it means that the risk is reduced, and the lower the figure, the lower the risk.) No particular food group stood out except for perhaps fat type.

The point is that is it the overall diet that is important not particular food types. This latter view is pushed by so many diets which claim that by eating or avoiding a particular food you will improve your health. This study shows that this approach is incorrect.

Mediterranean and similar diets outside the Mediterranean region.

There is now considerable evidence that Mediterranean and related diets are highly effective, particularly in reducing heart disease. A study done in the Greeks and Anglo-Celts in Melbourne, Australia demonstrated a 17% reduction in mortality if a traditional Mediterranean diet was adhered to for both Greeks and Anglo-Celts. This is evidence that the benefits of such a diet are available to all (Kouris-Blazos 99). See section on Mediterranean diet in What to eat.

Other diets similar to the Mediterranean diet: the Lyon Diet.

The Lyon Diet Heart Study was a controlled study where a diet similar to the Mediterranean diet was given to half the group. The diet was described as high in cereal derived foods, fruit and vegetables, less meat except fish, either canola or olive oil and no butter and cream. The risk of heart attack and poorly controlled heart pain were reduced by 70%, along with a reduction in heart failure (De Lorgeril 99).

The Indo-Mediterranean diet.

In a controlled Indian study of an Indo-Mediterranean diet rich in alpha linoleic acid, intervention group had half the rate of cardiac events as did the control group. Sudden cardiac death was reduced almost by two thirds (Singh 02).

Adoption of a Mediterranean diet will reverse the chronic disease processes induced by the typical western diet.

An Italian study compared a typical but closely monitored Mediterranean diet to a "prudent" diet of carbohydrates 50-60%, proteins 15-20%, total fat <30%. The changes in the Mediterranean group were impressive: greater weight loss, lower levels of inflammatory markers in the blood, decreased insulin resistance (associated with type II diabetes) and other features of the metabolic syndrome (a group of disorders associated with insulin resistance including high blood pressure, diabetes, bad lipid profiles etc.) were reduced by half. In other words, the

Mediterranean diet reversed the chronic diseases induced by the typical western diet (Esposito 04).

Even in a major negative study, subgroup analysis showed that those who adhered most closely to the dietary intervention have very positive outcomes. The Women's Health Institute controlled study involving almost 49,000 participants from 1993 to 2005 examined the effect where half of the participants reduced their dietary fat by 20% and increased fruit and vegetables to at least 5 servings/day and cereals to 6 servings per day, features somewhat similar to the Mediterranean diet (Prentice 06). The variables tested for were breast cancer, colon cancer and heart disease. The major problem with this study was that in the intervention group, there was a slippage in compliance to the test diet as time went on. This meant that the overall results were largely negative but in a subgroup analysis, those that stuck to the diet most closely showed significant reductions in breast cancer and heart disease (Trivedi 06).

Why do Mediterranean diets reduce cardiac disease so much? This is not known exactly but there is reasonable evidence for two factors. One is that the blood lipid profile is improved substantially by a diet where the majority of fats are mono or polyunsaturated as found in plant oils such as olive and canola. Such fats cause a drop in low density lipoprotein (harmful) and a rise in high density lipoprotein (good) fats in the blood. A second mechanism is that the fruit and vegetables are loaded with antioxidants which mop up free radicals. These radicals impair and damage endothelial cell (cells that line the blood vessels) function (Giugliano 05).

One of the great paradoxes has been why isolated antioxidants such as vitamin E and beta carotene given in the form of medications have either had no effect or actually increased the death rate. One intriguing explanation may be that plant-based antioxidants are bound to fibre and thus hang around in the gastro-intestinal tract where they neutralize free radicals either in the food or generated in the gut, especially in the highly acidic environment of the stomach. Antioxidants given as a medication unbound to fibre will not have this effect (Melton 06).

Even components of the Mediterranean diet can help: eating wholegrain foods regularly improve health. As part of the Nurses Health Study, participants were divided into five groups relating to intake of wholegrain foods from close to none up to just under 3 servings per day in the highest intake group. It should be noted that in this highest group, these participants also had higher intakes of carbohydrates, fruit and vegetables, dietary fibre and lower intake of fats, cholesterol and alcohol. There was a significant lowering of the risk of stroke in those who consumed more wholegrain foods, the relative risk being halved (Simin 00).

The Japanese

The Japanese example: people with the greatest longevity in the world.

The traditional diet in Japan has been one based on rice and other grains, fish, shellfish and seaweeds and low intake of land animal protein including dairy. With the Westernisation of Japan, cereal consumption has decreased somewhat from 118 kg/yr in 1955 to 104 kg/yr in 1990 and meat consumption increased from 5 to 29kg/y in the same period. As a consequence the incidence of coronary artery disease has risen but not to the levels of other Western countries. A possible explanation is that there was a parallel increase in consumption of fruit from 12 to 37 kg/yr and vegetables from 83 to 118 kg/yr during this time (Nestle 99). Hence the Japanese diet remains a predominantly plant-based diet.

References:

(Barnard 05) Barnard ND, Scialli AR, Turner-McGrievy G, Lanou AJ, Glass The effects of a low-fat, plant-based dietary intervention on body weight, metabolism, and insulin sensitivity. *Am J Med.* 2005;118:991-7.

(De Lorgeril 99) Michel de Lorgeril, Patricia Salen, Jean-Louis Martin, Isabelle Monjaud, Jacques Delaye and Nicole Mamele. Mediterranean Diet, Traditional Risk Factors, and the Rate of Cardiovascular Heart Complications After Myocardial Infarction : Final Report of the Lyon Diet Study. *Circulation* 1999;99:779-785

(Colombo 05) Colombo C, Muti P, Pala V, Cavalleri A, Venturelli E, Locardi M, Berrino F, Secreto G. Plant-based diet, serum fatty acid profile, and free radicals in postmenopausal women: the diet and androgens (DIANA) randomized trial. *Int J Biol Markers* 2005; 20:169-76.

(Esposito 04) Katherine Esposito, Raffaele Margella, Miryam Ciotola, Carmen Di Palo, Francesco Giugliano, Giovanni Giugliano, Massimo D'Armiento, Francesco D'Andrea, Dario Giugliano. Effect of a Mediterranean-Style Diet on Endothelial dysfunction and Markers of Vascular Inflammation in the Metabolic Syndrome. A Randomized Trial. *JAMA.* 2004;292:1440-1446

(Giugliano 05) Dario Giugliano Katherine Esposito. Mediterranean Diet and Cardiovascular Health. *Ann. N.Y. Acad. Sci.* 2005;1056: 253–260

(Hegsted 2000) D.M. Hegsted. From Chick Nutrition to Nutrition Policy. *Ann. Rev. Nutr.* 2000;20:1-19

(Key 99) Timothy J. Key*, Gwyneth K. Davey and Paul N. Appleby. Health benefits of a vegetarian diet. *Proceedings of the Nutrition Society* 1999; 58:271–275

(Kouris-Blazos 99) Antigone Kouris-Blazos, Charalambos Gnardellis, Mark L. Wahlqvist, Dimitrios Trichopoulos, Widjaja Lukito, Antonia Trichopoulou. Are the advantages of the Mediterranean diet transferable to other populations? A cohort study in Melbourne, Australia. *British Journal of Nutrition* 1999;82:57–61

(Melton 06) Lisa Melton. The antioxidant myth: a medical fairy tale. *New Scientist* 2006; 5th August issue.

(Millward 99) D. J. Millward. The nutritional value of plant-based diets in relation to human amino acid and protein requirements. *Proceedings of the Nutrition Society* 1999; 58:249–260

- (Millward 99B)** D. J. Millward. Optimal intakes of protein in the human diet. *Proceedings of the Nutrition Society*. 1999; 58:403–413
- (Prentice 06)** Prentice R.L. et al. The Women's Health Initiative Randomized Controlled Dietary Modification Trial. *JAMA*. 2006;295:629-642
- (Simin 00)** Liu Simin, JoAnn Manson, Meir Stampfer, Kathryn Rexrode, Frank Hu, Eric Rimm, Walter Willett. Whole Grain Consumption and Risk of Ischemic Stroke in Women: A Prospective Study. *JAMA*. 2000;284:1534-1540
- (Singh 02)** Ram B Singh, Gal Dubnov, Mohammad Niaz, Sarawati Ghosh, Reema Singh, Shanti Rastogi, Orly Manor, Daniel Pella, Elliot Berry. Effect of an Indo-Mediterranean diet on progression of coronary artery disease in high risk patients (Indo-Mediterranean Diet Heart Study): a randomised single-blind trial. *Lancet* 2002; 360:1455-1461.
- (Singh 03)** Pramil N Singh, Joan Sabaté, and Gary E Fraser. Does low meat consumption increase life expectancy in humans? *Am J Clin Nutr* 2003;78(suppl):526S–32S.
- (Richter 04)** Richter V, Rassoul F, Hentschel B, Kothe K, Krobara M, Unger R, Purschwitz K, Rotzsch W, Thiery J, Muradian K. Age-dependence of lipid parameters in the general population and vegetarians. *Z Gerontol Geriatr*. 2004;37:207-13.
- (Trichopoulou 97)** A Trichopoulou, P. Lagiou. Healthy Traditional Mediterranean Diet: An Expression of Culture, History, and Lifestyle. *Nutrition Review* 1997;55:383-389.
- (Trichopoulou 03)** Antonia Trichopoulou, Tina Costacou, Christina Bamia, Dimitrios Trichopoulos. Adherence to a Mediterranean Diet and Survival in a Greek Population. *NEJM* 2003;348:2599-2608
- (Trivedi 06)** Bijal Trivedi. The Good, the Fad and the Unhealthy. *New Scientist* 2006; 191; No.2570:42-49